Diabetes and Exercise:
The Great Blood Sugar Balancing Act

By Gary Scheiner MS, CDE

Last month, I saw two very different clients with two very similar problems.

One was a 62 year-old man named Anthony who has type-2 diabetes. Anthony's wife likes to drag him outside for 45-minute walks after dinner. "It's good for him to help him lose weight," she said. "But he keeps getting low on the way home. I give him extra food, but it just defeats the whole purpose. Maybe we should give it up."

The other was a teenage girl, Liz, whose father expressed concern over how her diabetes is affecting her swimming performance. "We need her blood sugars tight when she competes," he explained. "Trouble is, she goes low during practice, so we give her extra carbs. Then she goes way up high for the meets, so she gets tired and doesn't swim well. And if we cover the high, she winds up low during the night or even the next day. Up and down. Up and down."

Two very different people with two very similar problems: difficulty controlling blood sugar levels during physical activity. Managing blood sugar levels during physical activity is important not only for preventing hypoglycemia, but also for improving physical performance: research has shown that strength, speed, flexibility and stamina are all impaired by high blood sugar levels. It is not usually *dangerous* to exercise with a high blood sugar level (as long as you are not spilling ketones), but performance will be influenced by even moderately elevated blood sugars.

To understand what it takes to control blood sugar during active situations, we need to go back to the basics. Blood sugar regulation involves a complex interaction between the factors that raise blood sugar: carbohydrates in the diet and stress hormones (causing insulin resistance and extra glucose production by the liver); and factors that lower blood sugar: insulin and oral diabetes medications, and physical activity (by enhancing insulin sensitivity). A change in one requires a change in something else in order to keep the balance

Factors That Raise Blood Sugar	**Factors That Lower Blood Sugar**
Carbohydrates	Insulin
Stress Hormones	Muscle Activity

Physical activity can actually effect blood sugar in work a number of ways. Muscle cells are one of the main targets for insulin, whether it is insulin your body produces or insulin that you inject. With increased activity, muscle cells become much more sensitive to insulin. This

enhanced insulin sensitivity may continue for many hours after exercising, depending on the extent of the activity. The more intense and prolonged the activity, the longer and greater the enhancement in insulin sensitivity.

With enhanced insulin sensitivity, insulin exerts a greater force than usual. A unit that usually covers 10 grams of carbohydrate might cover 15 or 20. A unit that normally lowers the blood sugar by 50 mg/dl might lower it by 75.

Some forms of physical activity, most notably high-intensity/short duration exercises and competitive sports, can produce a short-term rise in blood sugar levels followed by a delayed drop. This is due primarily to the stress hormone production or "adrenaline rush" that accompanies these kinds of activities.

Let's take a look at these two different situations in greater detail.

Aerobic Activities

Most **daily activities** (including yardwork, cleaning, shopping, filing, playing, sex, and anything else that has us using our muscles for more than a few minutes) and **aerobic exercises** (activities performed at a challenging but sub-maximal level over a period of 20 minutes or more) will promote a blood sugar drop due to enhanced insulin sensitivity and accelerated glucose consumption by muscle cells. To prevent low blood sugar, one can reduce insulin/medication, increase carbohydrate intake, or a combination of both.

When exercise is going to be performed within an hour or two after a meal, the best approach is usually to reduce the mealtime insulin or oral medication. If you take insulin and plan to exercise at a time that you do not normally take rapid-acting insulin, you would be best served by consuming extra carbohydrate prior to the activity. Also, note that for activities lasting less than 2 hours, we only reduce the rapid-acting insulin. It is not usually helpful to reduce intermediate-acting or long-acting insulin unless your activity is going to last for more than 2 hours.

When adjusting mealtime insulin, both aspects (the dose to cover food and the dose to cover a high reading) are made more effective by exercise and need to be reduced. To accomplish this, I like to use an activity "multiplier". Essentially, this means that you calculate your mealtime insulin as usual (based on the food and the blood sugar level), and then multiply the dose by a factor that results in a lower dose:

Activity Multipliers ↘	**Short** Duration (15-30 minutes)	**Moderate** Duration (31-60 minutes)	**Long** Duration (1-2 hours)
Low intensity (relatively easy)	.90	.80	.70
Moderate intensity	.75	.67	.50
High intensity (very challenging)	.67	.50	.33

For example, if I take a leisurely 20-minute bike ride after dinner (I consider it "low intensity"), I multiply her dinner insulin dose by .90, which reduces the dose by 10%. If I plan a much more intense 90-minute ride up and down hills (which I consider "high intensity"), I would multiply my dinner dose by .50, which reduces my dose by 50%.

What about Anthony, whose wife likes to take him out for those 45-minute, moderate-intensity walks? If Anthony takes rapid-acting insulin at dinner, he should try reducing his insulin by 33% (multiply his usual dose by .67). Not only will this help him to avoid hypoglycemia, but it will also enable him to lose more weight since excess insulin tends to promote weight gain.

Medication Changes

If Anthony took oral medication for his diabetes, he may or may not need to reduce or eliminate the dose. Only certain medications can cause hypoglycemia; medications that do not have the potential to cause hypoglycemia should not be changed. Although it is not an "oral" medication, Byetta (exenatide) does not tend to cause hypoglycemia.

If you take a medication that can cause hypoglycemia, it is usually recommended that you take your usual dose with your first couple of exercise sessions and see what happens. If your blood sugar drops below 80mg/dl during or after exercise, reducing or eliminating the medication might be in your best interest. Check with your doctor before making this type of change on your own.

When Snacks Are Needed

Under certain conditions, extra food intake will be necessary to prevent hypoglycemia during exercise. For example, when exercise is going to be performed before or between meals, reducing the insulin at the previous meal would only serve to drive the pre-workout blood sugar very high. A better approach would be to take the normal insulin dose at the previous meal, and then snack prior to exercising. If you engage in exercise soon after you have already taken your usual insulin/medication, snacking will be your only option for preventing hypoglycemia. Also, during very long-duration endurance activities, hourly snacks may be necessary *in addition* to reducing insulin/medication.

The size of the snack depends on the duration and intensity of your workout. The harder and longer your muscles are working, the more carbohydrate you will need to eat in order to maintain your blood sugar level. The amount is also based on your body size: the bigger you are, the more fuel you will burn while exercising, and the more carbohydrate you will need.

Meds that CAN cause hypoglycemia

- **Sulfonylureas** (glipizide, glyburide)
- **Meglitinides** (Prandin, Starlix)
- **Combinations** that contain any of the above medications

Meds that DO NOT cause hypoglycemia

- **Metformin** (Glucophage)
- **Acarbose** (Precose)
- **Thiazoladinediones** (Actos, Avandia)

Granted, there is no way of knowing *exactly* how much you will need, but the chart below should serve as a safe starting point. To use the chart, find your approximate body weight and look down the list to find the intensity of your exercise. The number in the column represents the grams of carbohydrate that you will need *per hour* of activity. If you will be exercising for half an hour, take half the amount before the activity. If you will be exercising for two hours, take the full amount at the beginning of each hour.

	Carbohydrate Needed Per **60 Minutes** of Physical Activity				
	50 lbs (23 kg)	100 lbs (45 kg)	150 lbs (68 kg)	200 lbs (91 kg)	250 lbs (114kg)
Low Intensity	5-8g	10-16g	15-25g	20-32g	25-40g
Moderate Intensity	10-13g	20-26g	30-40g	40-52g	50-65g
High Intensity	15-18g	30-36g	45-55g	60-72g	75-90g

The best way to determine the optimal size and frequency of your snacks is to test your blood sugar before and after the activity. If it holds steady, you have found the magical number of carbs to consume. If it is rising, cut back on the number of carbs. If it is dropping, add some more carbs or eat more frequently the next time.

Anaerobic Activities

As mentioned previously, it is not unusual to experience a blood sugar rise at the onset of high-intensity/short-duration exercise. This is caused by a surge of stress hormones or "adrenaline". Exercises that often produce a short-term blood sugar rise include:

- Weight lifting (particularly when using high weight and low reps)
- Sports that involve intermittent "bursts" of activity like baseball or golf
- Sprints in events such as running, swimming and rowing
- Events where performance is being judged, such as gymnastics or figure skating
- Sports activities in which winning is the primary objective

Liz, mentioned earlier, was experiencing this exact problem. During swim *practices*, her blood sugar would drop steadily, requiring extra snacks. But swim *meets* caused just the opposite effect. Her blood sugar would rise sharply during swim meets due to the stress and competitive nature of the events, and this would hinder her performance. Once she eliminated the pre-meet snacks and started taking a little extra insulin beforehand, her blood sugars stayed closer to normal, and her performance went to a whole new level. In her first meet

trying this approach, she set a p.r. (personal record) and took second place in the 50-meter freestyle!

Covering the Highs

To determine how much extra insulin to take before an event of this nature, consider *how much* your blood sugar normally rises. If it goes up 200 mg/dl and your sensitivity factor is 50 mg/dl per unit (you drop 50 points per unit of insulin), you would normally need to give 4 units to prevent the rise. DO THIS AND YOU MIGHT PASS OUT. Remember, physical activity makes your insulin more potent! Give yourself *half* the normal amount. And give it about half an hour beforehand so that it will keep you from being too high when the activity begins. In Liz's case, she normally rises about 150 points during a meet, and her usual insulin sensitivity is 25 points per unit. Instead of taking 6 units before the meet, she takes 3 units.

The same "half-the-usual-dose" rule applies to high blood sugars immediately before or immediately after competitive/high-intensity events. Take half the usual "correction insulin" for high blood sugars in these situations.

If you are nervous about giving insulin before exercise, check your blood sugar more often than usual (perhaps every half hour or so), and have glucose tablets or some other form of fast-acting carbohydrate nearby. With some experience, you will develop greater confidence and have the ability to fine-tune your correction doses.

Delayed Effects

Ever finish a workout with a terrific blood sugar level only to go low several hours later or overnight? Many aerobic activities (particularly those that are long or intense) and most anaerobic exercises cause blood sugars to drop several hours later. This phenomenon even has its own name: *Delayed Onset Hypoglycemia*. There are two reasons why this takes place: prolonged, enhanced sensitivity to insulin among muscle cells, and the need for muscle cells to replenish their own energy stores (called glycogen) following exhaustive exercise.

Delayed-onset hypoglycemia is unique to each individual. The best way to deal with it is to keep records of when it happens (after what types of activities? how many hours later?), and then make adjustments to prevent it. For example, Liz tends to drop low in the middle of the night following her 2-hour evening practices. To fix it, she lowered her pump's basal insulin delivery by 40% for 8 hours following her practices. Those taking injections can lower their intermediate or long-acting insulin by 20-25%. Anyone taking insulin or an oral medication that may cause hypoglycemia can have an extra snack prior to the time that the blood sugar tends to drop. Ideally, the snack should contain slowly-digesting (low-glycemic-index) carbohydrates. Examples include whole fruit, milk, yogurt, peanut butter, pasta or chocolate (Finally, a therapeutic application for chocolate!!!)

Think Before You Stink

Exercise and other daily activities are meant to be enjoyed. Managing your blood sugars effectively during and after physical activity will ensure that you feel good, stay safe and perform your best. Hey, it even worked for Anthony. Not only is he walking after dinner without dropping low, he seems to actually enjoy it now. Just don't tell his wife!

Editor's note: Gary Scheiner is a Certified Diabetes Educator and Exercise Physiologist with a private practice specializing in intensive diabetes management and lifestyle modification for children and adults. He offers his services via phone and the internet to clients throughout the world. For questions or more information, you may contact him at gary@integrateddiabetes.com, or call 877-735-3648.